

An Arabic report about supernova SN 1006 by Ibn Sīnā (Avicenna)

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We present here an Arabic report about supernova 1006 (SN 1006) written by the famous Arabic scholar Ibn Sīnā (Lat. Avicenna, AD 980-1037), which was not discussed in astronomical literature before. The short observational report about a new star is part of Ibn Sīnā's book called *al-Shifā'*, a work about philosophy including physics, astronomy, and meteorology. We present the Arabic text and our English translation. After a detailed discussion of the dating of the observation, we show that the text specifies that the transient celestial object was stationary and/or tail-less (*a star among the stars*), that it *remained for close to three months getting fainter and fainter until it disappeared*, that it *threw out sparks*, i.e. it was scintillating and very bright, and that the colour changed with time. The information content is consistent with the other Arabic and non-Arabic reports about SN 1006. Hence, it is quite clear that Ibn Sīnā refers to SN 1006 in his report, given as an example for transient celestial objects in a discussion of Aristotle's *Meteorology*. Given the wording and the description, e.g. for the colour evolution, this report is independent from other reports known so far.

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1 Introduction: Supernova 1006

Historic observations of supernovae (SN) are important to understand SNe, neutron stars, and SN remnants (SNR): Historic reports can deliver the date of the observation (hence, the age of the SNR and, if existing, of the neutron star) together with a light curve (hence, possibly the SN type), sometimes the colour and its evolution, and the position of the SN, which is needed to identify the SNR and, if existing, the neutron star and/or pulsar wind nebula. Such historic observations have been used very successfully for SNe 1006 (from Eastern Asia, Arabia, and Europe), 1054 (from Eastern Asia and Arabia), 1181 (only from Eastern Asia), and SNe 1572 and 1604 (from Eastern Asia and Europe), plus a few more SNe from the 1st millennium AD (see Stephenson & Green 2002, henceforth SG02, and references therein). While the Arabic report about SN 1054 merely confirms a bright new star in Gemini/Taurus around AD 1054, the Arabic reports about SN 1006 present a lot of detailed information (Goldstein 1965; Cook 1999; SG02; Rada & Neuhäuser 2015).

According to historic observations and follow-up observations, SN 1006 and its SNR G327.6+14.6 have a distance of 2.18 ± 0.08 kpc with very small extinction (Winkler et al. 2003); several arguments speak for a SN type Ia explosion (see Schaefer 1996); for a SN type Ia, the peak apparent

brightness would then be -7.5 ± 0.4 mag (Winkler et al. 2003).

SN 1006 was observed by the Yemeni observer(s) around Apr 17/18 (Rada & Neuhäuser 2015), by ^cAlī ibn Riḍwān since Apr 30 (Goldstein 1965; SG02), and in China and Japan since the end of April or early May (SG02). The positional information by ^cAlī ibn Riḍwān (ecliptic longitude range) led to the identification of the SNR (together with the right ascension range from the Chinese and the declination limit from St. Gallen), see Stephenson et al. (1977) and SG02. Several Arabic observers noted stationarity. The report of Ibn Abī Zar^c (died in or after AD 1326) from a Moroccan source about SN 1006 (Goldstein 1965) – based on the edition of the Arabic and Latin text by Tornberg (1843) – is the only source possibly mentioning a day-time observation: *Its appearance was before sunset ...* (SG02).

The following Arabic terms were used for historic observations of SNe:

- *kawkab*, which means *star* or *planet*, or more generally *celestial object*, used e.g. for SN 1006 by Ibn al-Jawzī, Ibn al-Athīr, and Ibn Abī Zar^c (Goldstein 1965),
- *najm*, which means just *star*, e.g. SN 1006 by al-Yamānī and Ibn al-Dayba^c (Rada & Neuhäuser 2015),
- *nayzak*, which can mean a *comet* or *new star*, e.g. SN 1006 by ^cAlī ibn Riḍwān and Ibn Abī Zar^c (Goldstein 1965), but also something like *spectacle* or *transient celestial event*,
- *athar*, which means *trace*, but which was also used for SN 1006 and SN 1054, and

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- *kawkab atharī* as *spectacular star* for SN 1054 by Ibn Abī Uṣaybiʿa (Brecher et al. 1978).

If the observed object is classified just as some kind of *star*, but the duration of appearance is limited (to e.g. a few months), the object can be identified as transient. The class of *transient celestial objects* is often characterized by further details, whether e.g. star-like, stationary, and/or with or without tail, which then classifies it as, e.g., nova, SN, or comet. See Kunitzsch (1995) for a review of the Arabic words used for stars and transient celestial objects.

In their text book on historic SNe, Stephenson & Green (2002) write in the chapter on *Future Prospects*:

In our view Arab writings have real potential as sources of further records of this SN [1006] – and possibly of that of AD 1054.

Indeed, we present here such a new record of SN 1006.

We present the Arabic text and our English translation in Sect. 2. Then, in Sect. 3, we date the observation and interpret the text. We summarize our findings in Sect. 4.

2 Ibn Sīnā and his report about SN 1006

Abū ʿAlī al-Ḥusain b. ʿAbdallāh b. Sīnā (short Ibn Sīnā, Lat. Avicenna) was a Persian polymath¹ and lived from AD 980–1037; he wrote books about theology, medicine, and natural sciences including astronomy; Ibn Sīnā follows in most topics Aristotle and Ptolemy, but also tried to improve on the quality and quantity of celestial measurements (see, e.g., Sezgin 1978). He invented the Jacob’s staff or cross staff (Lat.: *Baculus Jacobi*) for precise altitude measurements (Wiedemann 1927), later replaced by the sextant. In his works on the *Almagest* and in *al-Shifāʾ*, Ibn Sīnā describes some of his own observations, including what he interpreted as Venus transit,² which was either a sunspot or the Venus transit of AD 1032 May 24 (Goldstein 1969; Kapoor 2013).

Ibn Sīnā’s encyclopaedic book entitled *Kitāb al-Shifāʾ* (Book of Healing) is his major work on philosophy, written from about AD 1013 to 1023; a nearly complete manuscript is located in the Bodleian Library, UK; a critical edition of the Arabic text has been published by Madkūr et al. (1965), which we have used for our work (see Fig. 1). In that work, Ibn Sīnā discussed Aristotelian philosophy including natural sciences. During the discussion of Aristotle’s *Meteorology* about transient celestial phenomena in the fifth volume, he mentioned a new star seen in 397h (AD 1006–1007).

¹ Even though he was a *Persian* scholar, we think that it is correct to speak here of an *Arabic* report about SN 1006, because the transmitted text itself is written in Arabic.

² In book IX of his *Almagest* and very similar in the astronomy chapter of *al-Shifāʾ*: *I say (that) I saw (myself) Venus as/like a black dot (spot) on the surface/disc of the sun*, given without date (Goldstein 1969; Kapoor 2013); this is confirmed by two later authors, namely by Naṣīr al-Dīn al-Tūsī (*al-Shaikh Abū ʿAlī b. Sīnā mentions in his books that he had seen Venus as a spot on the surface of the sun*) and by Yahuda b. Solomon Kohen (*Avicenna saw Venus appearing like a spot in the midst of the sun*) (Goldstein 1969).

We would like to remark how this short text (Fig. 1) about what is most certainly SN 1006 was found: In his review of Sezgin (1979), Goldstein (1982) reported that he (Goldstein) was told by A.I. Sabra that there is a mention of SN 1006 in Ibn Sīnā’s *Kitāb al-Shifāʾ*:

Professor A.I. Sabra informs me that a passage in Avicenna’s *Meteorology* also mentions the super-nova of 1006.

We present here the Arabic text from the edition of Madkūr et al. (1965), page 73, lines 12 to 17 (see Fig. 1):

(line 12) *fa-yaʿriḍu li-dhālīka an yabqā iltihābuhā wa-ishtiʿāluhā*

(line 13) *muddatan ʿawwāla immā ʿalā ʿṣurat dhuʿāba aw dhanab, wa-aktharuhu shamālī wa-qad yakūnu janūbīyan, wa-immā ʿalā*

(line 14) *ʿṣurat kawkab min al-kawākib, ka-lladhī ʿazahara fī sanat sabʿ wa-tisʿīn wa-thalāth-mīʾa li-l-hijra,*

(line 15) *fa-baqiya qarīban min thalāthat ashhur yaṭṭufu wa-yaṭṭufu ḥattā iḍmaḥalla, wa-kāna fī ibtidāʾihī ilā l-sawād*

(line 16) *wa-l-khudra, thumma jaʿala kull waqt yarmī bi-l-sharar wa-yazdādu bayāḍan wa-yaṭṭufu ḥattā iḍmaḥalla, wa-qad*

(line 17) *yakūnu ʿalā ʿṣurat liḥya, aw ʿṣurat ḥayawān lahu qurūn, wa-ʿalā sāʾir al-ṣuwar.*

Our English translation is as follows (words in round brackets are missing in one or some manuscripts, square brackets are our additions):

It therefore happens that the burning and flaming stays for a (long) while, either in form of a lock of hair or with a tail [i.e. in form of a comet], mostly in the north, but sometimes also in the south, or in form of a star among the stars [*kawkab min al-kawākib*] – like the one which appeared in the year 397(h). It remained for close to three months [*qarīban min thalāthat ashhur*] getting fainter and fainter until it disappeared; at the beginning it was towards a darkness and greenness, then it began to throw out sparks [*yarmī bi-l-sharar*] all the time, and then it became more and more whitish and then became fainter and disappeared. It can also have the form of a beard or of an animal with horns or of other figures.

In the relevant chapter 5 of *al-Shifāʾ*, Ibn Sīnā discussed the *Meteorology* of Aristotle. Following Aristotle, Ibn Sīnā explains that most atmospheric optical phenomena and in particular those connected with humid air would be due to wet *anathymiasis* (evaporation), while all phenomena connected with thunder, blizzard, wind as well as meteors and comets (maybe including other transient celestial objects) would be due to dry *anathymiasis*. In the first sentence of the short quotation above, Ibn Sīnā obviously talks about what we today call comets (*form of a lock of hair or with a tail*). After describing the transient star of 397h, he continues to talk about other transient objects including what

نارا خالصة ، ولا يكون لها برد مطفىء ، ولا أيضا تصعد صعودا سريرا ممعنا في حيز النار إلى أن تبلغ المكان الشديد قوة النارية ، فيعرض لذلك أن يبقى الترابها واشتعالها مدة طويلة إما على صورة ذؤابة أو ذنب ، وأكثره شمالي وقد يكون جنوبيا ، وإما على صورة كوكب من الكواكب ، كالذى ظهر في سنة سبع وتسعين وثلاث مائة للهجرة ، فبقى قريبا من ثلاثة أشهر يطفئ ويلطف حتى اضمحل ، وكان في ابتدائه إلى السواد والخضرة ، ثم جعل كل وقت يرمى بالشرر ويزداد يابا ويلطف حتى اضمحل . وقد يكون على صورة لحية ، أو صورة حيوان له قرون ، وعلى سائر الصور ؛ وإنما يكون ذلك إذا كانت هناك مادة كثيفة واقنة ، تطفئ أجزاؤها يسيرا يسيرا وتحلل عنه متصعدة كروائد شعرية أو قرنية . ومنها المسماة أعترأ كأن تشريرها تشعير . وكل ما ثبت منها

(١) بالعدد : وبالعدد ، سا || في : ساقطة من ب ، ط (٢) كالوجود : كالوجود
 د ، ط ، م (٣) ويخلفها غيرها : ويخلفها غيره ب ، د ، سا ، ط || موضعها : موضع ب ، د ، سا ، ط .
 (٥) في حقيقة : وحقيقة سا (٧) مقامه : مكانه د ، سا || يشعل : ساقطة من د .
 (٨) وخفيفة : خفيفة سا (٩) وخلصت : وحصلت سا . (١٠) وذات : ذات سا
 (١١) ممعنا : ممعنا د (١٣) طويلة : ساقطة من د ، سا (١٤) للهجرة : الهجرية ط ؛
 ساقطة من سا (١٧) أو صورة : أو على صورة د ، سا || حيوان : حيوان ط (١٨) متصعدة : متصعدة م
 (١٩) تشريرها : بشررها د ، ط ، م || تشعير : تشعير د ، ط ، م || ما ثبت : ما ثبت ب ؛ ما يثبت ط .

Fig. 1 Here we show the Arabic text from the report of SN 1006 of Ibn Sīnā in *al-Shifā'* from the Arabic edition by Madkūr et al. (1965), page 73. The relevant text starts in the middle of the second line from the top and ends almost at the (leftmost) end of the 3rd-to-last line from the bottom of the main text. The writing in the left margin is the Arabic line number 15. The 4th line (line 14) reads (starting from the right) for the 2nd to 4th word *kawkab min al-kawākib*, i.e. *a star among the stars*, and at the end of that line it specifies the year (the leftmost word is *hijra*). The lines at the bottom indicate variant readings in different manuscripts, none of which change the content and meaning of the relevant text about the new star: the words for *long* and *hijra* are missing in one or two manuscripts.

we call comets (*it can also have the form of a beard ...*). He says that such an object *stays for a (long) while*, i.e. that it is transient. That the new *star among the stars* is discussed together with what we call comets is not surprising, as both refer to variable phenomena placed in the sub-lunar sphere. In other words, the term *comet* was in former times used for several kinds of transient objects including what we today call comets, novae, and supernovae.

Since Ibn Sīnā could have been an eyewitness of SN 1006, let us consider where he was living, when SN 1006 was visible: Ibn Sīnā left Bukhara (now Uzbekistan) between AD 999 and 1005 and went via Nishapur (Iran) at a geographic latitude of $36^{\circ}13'$ north and Merv (now Turk-

menistan) at $37^{\circ}40'$ north to Kāth (now Uzbekistan) at $41^{\circ}41'$ north, the ancient capital of the province of Khorasan south of the Aral lake, which is now called Beruni in honor of the Arabic scholar al-Bīrūnī, who was born here. Ibn Sīnā left Kāth in AD 1012. Hence, if Ibn Sīnā was an eyewitness of the new star in AD 1006/7, he would have observed it most likely from a location as far north as $36^{\circ}13'$ to $41^{\circ}41'$, probably the latter. The text does not unfold whether Ibn Sīnā was the observer himself.

3 Interpretation

Let us first consider the dating of the observation, then the other information content.

3.1 Dating

An apparent difference to other reports is the year of appearance mentioned here by Ibn Sīnā, namely the year 397h, while the other Arabic reports all give 396h.

The Muslim calendar is a lunar calendar, where the months (and years) start with the evening when a new crescent moon is seen (days run from evening to evening), see Quran, Sura 2, 189. There are no leap months. Months can usually last 29 or 30 days, since the synodic month lasts 29.26 to 29.80 days (29.53 days on average). If in history the Muslim months had alternating 29 or 30 days, then, in any period of 30 years, there should be 11 years with one month with one extra day (e.g. a lunar year with seven months with 30 days plus five months with 29 days).

The year is given in the Muslim Hijra era, i.e. the number of years after the start of the lunar year in which the Hijra took place, i.e. the emigration of the Islamic Prophet Muḥammad from Mecca to Medina, known as Hijra. This era, i.e. the year 1h started on AD 622 Jul 16/17 according to most scholars – but it may have been on AD 622 Jul 15/16 according to, e.g., de Blois (2000).

Any date given in the Muslim calendar can be converted to a Julian or Gregorian date with a precision of ± 2 days. The reason for this uncertainty is, among the uncertainty of the start of the era (see above), that it is not clear a posteriori when in history a month had an extra day³ and that the first sighting of a new crescent moon can be delayed due to, e.g., bad weather and/or difficult landscape. It is also possible that – even an experienced observer – claims to have seen the crescent new moon, even if it was not yet possible, so that a month would start one day too early (Doggett & Schaefer 1994). See, e.g., Spuler & Mayr (1961), de Blois (2000), Said et al. (1989), and Neuhäuser & Kunitzsch (2014) for more details about Muslim calendar rules.

Since the date given by Ibn Sīnā is very rough, just the year is given, we do not need to try to date the start of the year with high precision. According to the *calculated* Islamic calendar (Spuler & Mayr 1961), the year 397h started on AD 1006 Sept 26 (± 2) in the evening.

³ The artificially constructed *calculated* Islamic calendar uses leap days in certain, pre-defined years and months; in reality, we have to expect that, in each period of 30 years, there were 11 months which had an additional day (due to real, late crescent sighting) – in addition to those 354 days in a pure lunar calendar year with – on average – six months of 29 days plus – on average – six months of 30 days (the average synodic month length is 29.53 days, and not 29.50). Due to late crescent sighting, the month with one extra day did not necessarily follow the leap day/month rule in the calculated Islamic calendar used in, e.g., Spuler & Mayr (1961). Hence, this calendar can deviate by up to two days (Ginzel 1906; Spuler & Mayr 1961; de Blois 2000).

As mentioned before, all other observers gave much earlier dates for their first observation: ‘Alī ibn Riḍwān observed SN 1006 since AD 1006 Apr 30, the Chinese observers since May 1 (but possibly already on Apr 3), and in Japan, it was sighted first on Apr 28 or 30 (see Goldstein 1965; SG02); it is possible that SN 1006 was already observed on around Apr 17/18 in Yemen, see Rada & Neuhäuser (2015) for the evidence. The observer in St. Gallen reports to have observed the new star *for three months* (SG02); if that was all after sunset, given his location, he cannot have observed it after about July 10, so that he probably started to observe SN 1006 in April 1006. While most Arabic observers mention that they observed the SN for some 2–4 months, the Moroccan report mentions six months as visibility period, which would be until after conjunction with the Sun (Goldstein 1965; SG02). The Chinese have observed also the helical setting and rising of SN 1006 in AD 1007 (SG02). Hence, SN 1006 was still visible in the Muslim lunar year that started on AD 1006 Sept 26 (± 2) in the evening. SN 1006 was in conjunction with the Sun from mid Sept to mid Nov, so if it was observed in 397h, then it must have been after mid Nov 1006.

There are four possibilities to be considered for the interpretation of the year (397h) given by Ibn Sīnā:

1. Ibn Sīnā as eye-witness mistakenly gave the slightly wrong year in his text, e.g. a memory error or typo, possibly years after the observation, *al-Shifā'* was written AD 1014–1020.
2. The year was changed by mistake during the (oral ?) transmission from the observer to Ibn Sīnā from 396h to 397h.
3. A copying scribe made a mistake by changing the year from 396h to 397h.
4. The observer (possibly Ibn Sīnā himself) in fact observed SN 1006 in 397h, which started on AD 1006 Sept 26 (± 2), i.e. at or after heliacal rising after conjunction with the Sun (after mid Sept).

The latter (4) is less likely, because the star was brighter in the year 396h. The year 397h most certainly is given by mistake – just one year too late.

There is no other transient celestial object that could have been meant by Ibn Sīnā for 397h (AD 1006 or 1007), in particular no comet (see Ho Peng Yoke 1962 and Kronk 1999).⁴ Further circumstantial evidence for a visibility period in spring or mid AD 1006 is given by the fact that Ibn

⁴ Cook (1999) quoted some additional text from Yahyā ibn Saʿīd al-Anṭākī after the report for SN 1006 on what is most certainly a different transient object, e.g. a meteor or bolide: *Another star appeared with a strong light in the west during the time of the falling of night during Saturday night, 9 Shawwal [10 July], and it stayed long and grew great. Then it broke up into three parts and disappeared.* Appearance of the object in the west at falling of night is not consistent with SN 1006, which was within an azimuth 1h of the meridian at sunset. Even if the text here says *it stayed long and grew great*, this can be a bolide, which stayed relatively long for a bolide or meteor. The source for the latter object (bolide) can very well be a different source than for the SN report. SG02 did not even include this extra text in their citation of Yahyā ibn Saʿīd al-Anṭākī, obviously also because they consider it unrelated to SN 1006. Alternatively, the last sentences, if

Sīnā specified that the object was visible for *close to three months*, which is quite consistent with the other Arabic observers, who detected the object in April or May and monitored it for typically two to four months.

3.2 Stationarity, appearance, direction, duration, lightcurve, colour, and brightness

We can now discuss the other information content from Ibn Sīnā and compare it to other observers.

Taillessness (and/or stationarity). With the wording *in form of a star among the stars*, Ibn Sīnā probably means that the transient new object was tail-less – in contrast to the more common transient objects, comets with tails (*if form of a lock of hair/beard*), which move relative to the stars. The wording *a star among the stars* may also or alternatively mean stationarity. Other Arabic observers mentioned the stationarity: ^cAlī ibn Riḍwān (*It remained where it was and it moved daily with its zodiacal sign*), Ibn al-Jawzī wrote ... *and it remained fixed* ... (Goldstein 1965; SG02), and maybe also al-Yamānī and Ibn al-Dayba^c (*remained unchanged*).

Direction. Even though SN 1006 indeed appeared in the far south as seen from Arabia or Persia for Ibn Sīnā, we cannot conclude on the direction from his text. Even when he says that [comets appear] *mostly in the north, but sometimes also in the south, or in form of a star among the stars like the one which appeared in the year 397h*, he may just quote Aristotle for (normal) comets (or, more generally, transient celestial objects) to appear in both the north and the south, before then starting to discuss the new star of AD 1006.

Duration. The duration of visibility given (*qarīban min thalāthat ashhur* for *close to three months*) can mean a little less or a little more than three months, and it is consistent with most other Arabic scholars: ^cAlī ibn Riḍwān (four months), Ibn al-Jawzī and Ibn al-Athīr (*beginning of Sha^cbān ... until the middle of Dhū al-Qa^cdah*, i.e. 3.5 months), Moroccan report (*This star stayed for six months*), Yaḥyā ibn Sa^cīd al-Anṭākī (*it continued four months*, Cook 1999), al-Yamānī (*On the night of mid-Rajab in the year 396h, a star appeared ... In the night of mid-Ramaḍān, its light started to decrease and gradually faded away*, i.e. more than two months), and similarly Ibn al-Dayba^c (*on the night of mid-Rajab a star like Venus appeared ... It remained unchanged until the night of mid-Ramaḍān*, i.e. not less than two months). In particular if Ibn Sīnā (or his source) observed SN 1006 since about late April or early May 1006, and then for *close to three months*, then he could have observed until heliacal setting for his location.

pertaining to SN 1006, could either confirm the long visibility period and strong brightness (until July) or might be mis-dated (first appearance was April/May instead of July as given here). The wording *it broke up into three parts and disappeared* might be understandable as effect of strong scintillation at very low altitude, possibly around heliacal setting. When the sun was some 9 – 18° below the horizon, SN 1006 was clearly visible in the west (azimuth being 1.5 to 2.5h west of meridian).

Given that Ibn Sīnā was located quite far north in AD 1006, see Sect. 2, (either in Nishapur 36°13′ north or Merv 37°40′ north, or Kāth 41°41′ north, probably the latter), he could not observe SN 1006 for a long period (if he was the observer himself at all): His likely location Kāth has a similar geographic latitude as Naples, Italy (41° north), from where a new star is related to a 3 month period: *A very brilliant star shone, and a large drought happened for three months* (SG02 from the Annales Beneventani). St. Gallen is even further north at 47°25′, and surrounded by high mountains, where the new star was also seen for 3 months (SG02). As for the observer(s) in Naples, Ibn Sīnā could have observed SN 1006 only until about the end of July (if he observed only after sunset): On 1006 Jul 31, SN 1006 would have been at an altitude of about 5°30′ above the horizon at sunset with an apparent magnitude of about –1 mag. (We also take into account that the southern horizon is quite flat as seen from Kāth/Beruni towards the south: Kāth/Beruni is located at today's border of Uzbekistan to Turkmenistan and the latter has almost no high mountains, in particular not south of Kāth/Beruni.) Hence, the observer (whose report is transmitted by Ibn Sīnā) could have observed SN 1006 in May, June, and July (not later, but possibly earlier in April). He may have observed (part of) the rise, the peak, the decrease, and even the heliacal setting of SN 1006. The fact that Ibn Sīnā reports to have seen the new star for close to three months (probably May, June, July) is fully consistent with the other Arabic reports.⁵

Light curve. Ibn Sīnā also describes that the new star decreased in brightness before it disappeared (*getting fainter and fainter until it disappeared* and later *and then became fainter and disappeared*), as do the Yemeni authors: Al-Yamānī (*In the night of mid-Ramaḍān, its light started to decrease and gradually faded away*) and similarly Ibn al-Dayba^c (*its light diminished and it gradually faded away*). The connection of a gradual decrease in brightness with disappearance by Ibn Sīnā could well mean the process of heliacal setting. Because SN 1006 was observed by some observers even after conjunction with the Sun since the end of AD 1006, it is less likely that SN 1006 was not observable any more due to intrinsic faintness before heliacal setting. The Arabic word *fa-baqiya* in the text by Ibn Sīnā was translated here as *It remained* (for close to three months), which probably does not mean *It remained (fixed at its location)*, but rather in a temporal sense (that it was seen for close to three months), or possibly that *it remained (somewhat constant in brightness)*; also, stationarity may have been already mentioned by Ibn Sīnā in his previous sentence (*a star among the stars*).

Colour. The colour and its evolution is mentioned: *at the beginning it was towards a darkness and greenness, then it began to throw out sparks [yarmī bi-l-sharar], and then it*

⁵ For the observer in St. Gallen, the situation was even worse: he could observe SN 1006 only until July 10 at most given his even more northern location and the high mountains towards his southern horizon; since he observed for three months, he must have seen SN 1006 for his first time before May.

became more and more whitish This part of the text may be more difficult to understand. What we translated as *darkness* could even mean *blackness* or possibly *faintness*, but *black* is almost impossible as colour for a celestial object; while the meaning of *black* as *unfortunate* was also known and used in Arabic, this interpretation is unlikely here, because it is combined with *greenness* – and also because Ibn Sīnā is known to have opposed *black magic*, astrology etc. The wording *darkness and greenness* could mean *faint green-to-yellow* (at the beginning, i.e. before peak brightness). What is described as *green* in the sky is often *yellow* or *yellowish-to-greenish*, as yellow and green are very similar to each other. The Chinese have reported that the new star was *yellow* (SG02). Ibn Sīnā continues with *then it became more and more whitish*. In this case, Ibn Sīnā would report that the new star was first *yellowish-to-greenish* and then *more and more whitish*.

While it is also not clear whether our translation of the colours shows the intended meaning or even whether the transmitted text is somewhat corrupt in this part, his text can be interpreted in a consistent way as follows:

At the beginning it was towards a faintness and greenness meaning that it was faint and greenish-yellowish at the beginning (like the Chinese report: it *increased in brightness* and was *yellow*, see SG02), *then it began to throw out sparks all the time, and then it became more and more whitish*, i.e. that it was scintillating during the period of largest brightness (similar in China and in other Arabic reports) being more and more whitish (brighter?) during peak brightness. The colour evolution reported is independent from other Arabic reports, both regarding the content and details and regarding the Arabic wording.

Brightness. Ibn Sīnā reports that it *throws out sparks*, i.e. that it scintillated, this is again quite consistent with the other Arabic reports, consistent with a very bright luminosity: °Alī ibn Riḍwān (*it twinkled very much*), Ibn al-Jawzī (*It was glittering*), Ibn Saʿīd al-Anṭākī (*It had dazzling rays and a great rippling*), as well as al-Yamānī and Ibn al-Daybaʿ (*It showed a great turbulence*). The wording *yarmī bi-l-sharar* for *throw out sparks* for scintillation is different from other Arabic reports, again showing its independence. Since Ibn Sīnā does not compare the new star with either the brightest star(s) in the sky nor with Venus (the brightest planet in the sky), the new star was probably much brighter than the brightest stars – and even much brighter than Venus, i.e. brighter than about -5 mag, the largest possible brightness of Venus.

4 Summary

The presented record by Ibn Sīnā about a transient celestial object in 397h is quite clearly related to other credible reports about SN 1006, but original (however, dated one year too late). Within a discussion about presumably sub-lunar phenomena, Ibn Sīnā reports a transient celestial object in form of a tail-less *star among the stars*, which was seen for

close to three months, and it was scintillating; its colour may have changed first from greenish(-yellowish) to whitish, and then it gradually decreased in brightness (probably due to heliacal setting).

In general, Ibn Sīnā's text is consistent with other Arabic (and non-Arabic) records about SN 1006, the main addition is the colour evolution and some terms, e.g. *star among the stars* and *yarmī bi-l-sharar* for *throw out sparks*. Hence, the report is independent.

When °Alī ibn Riḍwān told us that *other scholars from time to time have followed it [SN 1006] and came to a similar conclusion* (SG02), he may have meant Ibn Sīnā, among others.

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